ZEL'DOVICH, Ya. B., RAYZER, Yu. P. (Moscow)

"On Radiation Generated by Strong Shock Waves."

report presented at the First All-Union Congress on Theoretical and Applied Mechanics, Moscow, 27 Jan - 3 Feb 1960.

ZELDOVICS, Ja.B. [Zeldovich, Ya.B.] (Moscow)

Charges of elementary particles. Fiz szemle 10 no.3:86-91 Mr '60.

ZEL'DOVICH, Ya.B., akademik (Moskva)

Progress made in direct transformation of heat into electricity. Fiz. v shkole 20 no.5:8-12 S-O '60. (MIRA 13:11)
(Thermoelectricity)

ZEL'DOVICH, Ya.B.

Quasi-stable states with a large isotopic spin in light nuclei. Zhur. eksp. i teor. fiz. 38 no.1:278-280 Jan '60. (MIRA 14:9)

1. Institut teoreticheskoy i eksperimental'noy fiziki AN SSSR.
(Nuclei, Atomic)

ZEL'DOVICH, Ya.B.

Scattering by a singular potential in the perturbation theory and in pulse representation. Zhur.eksp.i teor.fiz. 38 no.3: 819-824 Mr '60. (MIRA 13:7)

1. Institut teoreticheskoy i eksperimental'noy fiziki Akademii nauk SSSR.
(Scattering(Physics))

83719
S/056/60/038/004/012/048
B019/B070

24.6700

AUTHOR: Zel'dovich, Ya. B.

TITLE: Existence of New Isotopes 19 of Light Nuclei and the Equation of State of Neutrons 19

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 4, pp. 1123-1131

TEXT: P. E. Nemirovskiy (Refs. 1,2) studied the possible existence of isotopes in the range of $8 \leq Z \leq 84$, and A. I. Baz' (Ref. 3) in the range of $17 \leq A \leq 40$. Both predicted the existence of unknown isotopes of which O^{20} has been discovered in the meantime. In the present paper, the author studies the limits of stability of light nuclei, and predicts the existence of the following isotopes: He^8, Be^{12}, O^{13}, B^{15}, B^{17}, B^{19}, C^{16-20}, N^{18-21}, Mg^{20}. The table on page 1124 gives the isotopes predicted by Nemirovskiy, Baz', and the present author. The present author has made a theoretical study of the existence of heavy nuclei consisting only of neutrons. He first mentions that if such nuclei exist

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Existence of New Isotopes of Light Nuclei and the Equation of State of Neutrons

at all, their density must be esentially smaller than that of the usual nuclei. He has, therefore, studied the properties of a neutron liquid of low density. This problem to that of a Fermi gas with resonance interaction of the particles, the energy of the gas being proportional to $\omega^{2/3}$ (ω density of the gas). For finding out the equilibrium density and the coupling energy, the author has studied the effective radius of the nuclear forces and the interaction in the state with $l \neq 0$. The accuracy of the calculations is not sufficient to determine the sign of the energy and to answer the question of the existence of neutron-nuclei. The author thanks A. I. Baz', V. I. Gol'danskiy, L. D. Landau, A. B. Migdal, and P. E. Nemirovskiy for discussions; and D. V. Grigor'yev for help in the work. There are 1 table and 16 references: 8 Soviet and 8 US.

SUBMITTED: October 22, 1959

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83772
S/056/60/039/003/030/045
B006/B063

24,6700

AUTHOR: Zel'dovich, Ya. B.

TITLE: The Theory of Instable States

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 3(9), pp. 776-780

TEXT: Exponentially damped states such as occur in alpha decay are described by a complex energy value whose imaginary part indicates the decay probability. The wave function of such a state increases exponentially with respect to the large-distance modulus. Thus, the ordinary methods of normalization, perturbation theory, and expansion in a series of eigenfunctions cannot be applied to such a state. In the present paper, the author develops a perturbation theory which yields an expression in the form of a quadrature for the change in the decay probability and the mean energy in the case of arbitrarily small potential changes. If the state is described at the first moment by a certain wave function, the wave function then approaches, in a long time interval, an exponentially damped function of a certain amplitude. This amplitude is also given in quadratures. When treating the problem of energy perturbation and of the amplitude

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of the state exponentially damped in time, the author uses a term that plays the role of the norm of this state:

$\lim\limits_{\alpha \to 0} \int_0^\infty \chi^2 \exp(-\alpha r^2) r^2 dr$. First, he considers a particle moving in a spherical barrier potential (α - particle in the Gamov theory of alpha decay), and shows that the perturbation-theoretical expression (1) for $\delta E'$ (where $E' = E_0 - i\gamma$) can be derived in an elementary way and may be written down in the simple form $\delta E' = \int \chi^2 \delta V d\tau / \int \chi^2 d\tau$. Then, he considers the non-steady problem, and studies the initial wave function $\psi(r, t=0) = \varphi(r)$ with the asymptotic solution $\psi(r,t) = A\exp(-iE't)\chi(r) + O(r,t)$, where $O(r,t)$ decreases for small r like $t^{-3/2}$. For this purpose, he compares the function $\psi(r,s) = -i \int_0^\infty \psi(r,t)\exp(ist)dt$, suggested by N. A. Dmitriyev, with the coefficients A and a from the solution $\psi(r,s) = a\chi(r)/(s-E') + \psi_1(r,s)$. Finally, he generalizes the formulas

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The Theory of Instable States

obtained to states with $l \neq 1$. He thanks G. A. Drukarev, A. B. Migdal, V. A. Fok, and L. A. Khalfin for discussions, and N. A. Dmitriyev for his helpful assistance. N. S. Krylov is mentioned. There are 6 references: 5 Soviet and 1 British.

SUBMITTED: April 16, 1960

Card 3/3

84421

S/056/60/039/004/039/048
B006/B056

24.6900

AUTHORS: Zel'dovich, Ya. B., Perelomov, A. M.

TITLE: The Effect of Weak Interaction 19 Upon the Electromagnetic Properties 21 of Particles

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 4(10), pp. 1115 - 1125

TEXT: It was the purpose of the present work to investigate the contribution made by weak particle interaction to electromagnetic interaction. In the introduction, the problem as such is discussed, and the contents of the paper is given. In section 2, the graphs (Figs. 1-6) which make a contribution to the electromagnetic properties of the neutrino, the leptons (e and μ), and the baryons are investigated; the contributions are determined in orders of magnitude of the weak interaction constant for individual cases. For this purpose, two variants of the theory are studied: that of four-fermion interaction and that of the intermediate, heavy, charged X-boson. In several cases, the order of g is reduced by the introduction of the X-boson, i.e.. the effect is increased. In section 3,

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The Effect of Weak Interaction Upon the Electromagnetic Properties of Particles

the general electromagnetic properties resulting from the Lorentz and gradient invariances of the theory, from the probability and the theory of universal weak interaction, and from the theory of the two-component neutrino are dealt with. In section 4, the interaction within the framework of the perturbation theory is investigated, and the order of magnitude of the divergence of the integrals obtained is determined. The characteristic electromagnetic properties of the particles are numerically estimated. In the case of baryons, one assumes that strong interaction replaces weak interaction already at momenta of the order of M_n (M_n - nucleon mass). In section 5, the experimentally observable particle scattering effects are discussed, especially the polarization of particles in the scattering plane, because this effect is related to parity non-conservation. Neutrino scattering by nuclei as well as the effects of new electromagnetic properties in nuclear physics are discussed. Section 6 deals with the problem of the possible modifications of the initial assumptions on weak interaction, by adding the derivative of the neutral currents to the ordinary derivative of the charge currents. The conditions under which the additional term does not lead to a decay

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The Effect of Weak Interaction Upon the Electromagnetic Properties of Particles

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B006/B056

and cannot be observed experimentally, are studied, as well as the effects which are due to the scattering of electrons by protons. The authors thank A. M. Brodskiy, G. M. Gandel'man, B. L. Ioffe, L. B. Okun', and K. A. Ter-Martirosyan for discussions. Ya. A. Smorodinskiy, A.I.Akhiyezer, L. N. Rozentsveyg, and I. M. Shmushkevich are mentioned. There are 6 figures and 21 references: 10 Soviet, 2 Italian, and 9 US.

SUBMITTED: March 23, 1960

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86930

S/056/60/039/005/049/051
B006/B077

24.6900

AUTHOR: Zel'dovich, Ya. B.

TITLE: The Dipole Moment of Instable Elementary Particles

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 5(11), pp. 1483 - 1485

TEXT: The conclusion following from the theory of combined inversion of L. D. Landau that the elementary particles possess no dipole moment cannot be applied to instable particles; this is shown in the present "Letter to the Editor". If a particle with spin and dipole moment is considered while the time axis is reversed it is obvious that there is no T-invariant relation, and considering the effect of the reversion of the time axis to an instable particle (that emits particles and spontaneously transmutes into an other particle) one can see at once that this proof of the nonexistence of dipole moments can not be applied to such particles. In order to examine the relationship between the instability of particles and the dipole moment the author considers the two reactions of a neutral spin-1/2-particle: $A^0 \rightleftarrows B^+ + C^-$ and $A^0 \rightleftarrows D^0 + E^0$. The first

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The Dipole Moment of Instable Elementary Particles

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reaction is assumed to be a virtual and the second a real decay. Using the results of a previous work (Ref.3) it can be shown that the violation of parity (assumed to be necessary for this reaction) together with the conservation of the T-invariance in the instable particle Hamiltonian leads to the appearance of a dipole moment that is to an apparent violation of the T-invariance. This result agrees with that of von Behrends (Ref.4) who investigated the decays $\Lambda = n + \gamma$ and $\Lambda = p + \pi^-$. He also ended up with a solution having terms that apparently contradict the T-invariance disregarded the T-invariance of the applied Hamiltonian. There are 4 references: 2 Soviet and 2 US.

SUBMITTED: September 7, 1960

Card 2/2

88457
S/056/60/039/006/049/063
B006/B063

24.6900

AUTHOR: Zel'dovich, Ya. B.

TITLE: The Form Factor of $K_{\mu 3}$ and K_{e3} Decays

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 6(12), pp. 1766-1769

TEXT: The decay of a K-meson into a pion and two leptons may be ascribed to the weak four-fermion interaction with $\Delta S = 1$. In this case, the decay proceeds via an intermediate state of a baryon-antibaryon pair. The momenta of the K-meson and the pion (p_K, p_π) are small compared to the baryon masses M_B. Hence, the velocities of the K- and π-mesons are assumed to be the characteristic quantities. In the rest system of the K-meson, the pion can reach a velocity of 0.87c. The author discusses a hypothesis according to which the four-velocity of K- and π-mesons (u_K, u_π) enters symmetrically into the expression for the matrix element of the interaction between K- and π-mesons and the lepton current. As usual, the matrix

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The Form Factor of $K_{\mu 3}$ and K_{e3} Decays

element of the process is formulated by $M = \sum V_{\alpha}\overline{\Psi}_{\mu e}\gamma_{\alpha}(1+\gamma_5)\Psi_{\nu}$. The velocities u_K and u_{π} are symmetrically introduced into this relation. The expression for the vector current, which corresponds to this hypothesis, reads as follows: $V_{\alpha} = \varphi(-u_K u_{\pi})\left[u_{K\alpha} + u_{\pi\alpha}\right]$. The form factor φ depends on the invariant, i.e., the product $u_K u_{\pi}$. $u_{K\alpha} = p_{K\alpha}/m_K$ $u_{\pi\alpha} = p_{\pi\alpha}/m_{\pi}$. The conclusions to be drawn from the fact that the divergence of the vector current vanishes are studied for these formulations. It is shown that div V = 0 holds only in the approximation of the isotopic invariance (that is to say, if the same mass is assumed for charged and neutral pions). The assumption of div V = 0 and different masses of π^+ and π^0 (as done by Weinberg et al. - Ref. 2 - and Marshak et al. - Ref. 3) leads to certain difficulties, e.g., an incorrect expression for the π_{e3} vector current. Finally, the results obtained by G. M. Gandel'man and the conclusions to be drawn from the above-described hypothesis for the reaction

$$K^+ \rightarrow p + \Lambda \rightarrow p + \overline{p} + e^+ + \nu \rightarrow \pi^0 + e^+ + \nu$$

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The Form Factor of $K_{\mu 3}$ and K_{e3} Decays

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in the Feynman perturbation theory are discussed. B. L. Ioffe, L. B. Okun', I. Ya. Pomeranchuk, and G. M. Gandel'man are thanked for discussions. There are 8 references: 5 Soviet, 2 US, and 1 Italian.

SUBMITTED: July 20, 1960

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82752

S/053/60/071/004/002/004
B004/B056

24.6600

AUTHORS: Zel'dovich, Ya. B., Gershteyn, S. S.

TITLE: Nuclear Reactions in Cold Hydrogen. I. The Mesonic Catalysis

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol. 71, No. 4, pp. 581 - 630

TEXT: The authors proceed from the catalysis of nuclear reactions in hydrogen by μ-mesons, which was discovered in 1957 in Berkeley by L. W. Alvarez et al. (Ref. 4). This phenomenon had been predicted also by A. D. Sakharov (Ref. 2) and Ya. B. Zel'dovich (Ref. 3). A systematic survey is given of the theoretical papers dealing with muon catalysis, and the possibility of a nuclear synthesis in cold hydrogen by means of "piezonuclear reactions" under high pressure is dealt with. The following reaction equations are mentioned: $p + p = d + e^{+} + \nu$ (2.2 Mev) (I);

$$p + d = He_3 + \gamma \text{ (5.4 Mev) (II)}; \quad d + d = \begin{cases} t + p \text{ (4 Mev)} \\ He_3 + n \text{ (3.3 Mev) (III)}; \\ He_4 + \gamma \text{ (24 Mev)} \end{cases}$$

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Nuclear Reactions in Cold Hydrogen.
I. The Mesonic Catalysis

$d + t = He_4 + n$ (17.6 Mev) (IV); $p + t = He_4 + \gamma$ (20 Mev) (V), and $t + t = He_4 + 2n$ (10 Mev) (VI). The quantum-mechanical tunnel effect is discussed, and it is stated that with the interatomic distances existing in ordinary molecules, no nuclear reaction occurs, but that such a reaction becomes possible if the electron is replaced by a μ^--meson. Part 2 describes the experiments carried out in Berkeley (Ref. 4) and in Liverpool (Ref. 5). Part 3 deals with the catalysis of nuclear reactions in hydrogen by means of μ-mesons, viz.: 1) The formation of the pμ mesic atom; 2) The formation of ppμ mesic molecules; 3) The transition of the μ-meson from a proton to a deuteron; 4) The formation of pdμ- and ddμ-mesic molecules, and 5) nuclear reaction in mesic molecules. In part 4 the mesic molecular processes in hydrogen are dealt with on the basis of Ref. 17. The adiabatic approximation for ordinary molecular processes is discussed, a precise defination of the adiabatic approximation for hydrogen mesic molecules is derived (Fig. 6, appendix I), a calculation of the levels of mesic molecules (Table II, Figs. 7,8), and of the binding energies (Table III) is given, transition of the μ-meson from a light to a heavy isotope (Tables IV, V), the scattering of mesic

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Nuclear Reactions in Cold Hydrogen.
I. The Mesonic Catalysis

atoms on nuclei (Table VI), the formation of mesic molecules (Table VII), and the transitions among the levels of mesic molecules are discussed. Furthermore, the calculated probability for the various mesic molecular processes are compared with experimental data, and in this way agreement, at least as regards the order of magnitude, is found. Part 5 deals with the nuclear reactions in mesic molecules. The following reaction constants are enumerated: $C_{III} = 2.10^{-16}$ cm^3/sec; $C_{IV} = 2.10^{-14}$ cm^3/sec and $C_{II} = 1.25.10^{-22}$ cm^3/sec, and for the probability of the nuclear reaction, the equation $w = C|G(0)|^2$ (C = reaction constant, G(0) = value of the wave function at a nuclear distance R = 0) (Tables VIII, IX) is written down. The nuclear reaction in the pdμ and ptμ mesic molecule is then discussed. In part 6 it is stated that no continuous nuclear reaction occurs. Part 7 mentions further experimental research work in the field of the μ-catalysis as being desirable. In appendix II, a calculation of mesic molecules with the same nuclei, and in appendix III a calculation of the spin states of mesic molecules is given. The authors

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Nuclear Reactions in Cold Hydrogen.
I. The Mesonic Catalysis

mention papers by Panovskiy (Ref. 24) and A. B. Migdal (Ref. 44). There are 9 figures, 9 tables, and 44 references: 17 Soviet, 16 US, 6 British, 2 German, 2 Italian, 2 Japanese, and 1 Swiss.

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S/053/60/072/002/002/005
B006/B067

AUTHORS: Baz', A. I., Gol'danskiy, V. I., and Zel'dovich, Ya.B.

TITLE: Some Isotopes of Light Nuclei

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol. 72, No. 2, pp. 211 - 234

TEXT: At present about 300 isotopes of light nuclei ($Z \lesssim 36$) are known of which abundant experimental material has already been collected. The present paper gives a survey of these data. After a short introduction the neutron-deficient isotopes ($Z > N$) are dealt with in chapter 2. Their properties can be predicted by the fact - which follows from charge invariance - that the properties of two isotopically conjugate nuclei (nucleus A, Z_1N_1 is the isotopically conjugate nucleus of nucleus A_1, Z_2N_2 if $Z_1 = N_2$ and $N_1 = Z_2$) exactly coincide up to the Coulomb corrections and the corrections for the neutron-proton mass difference. Since these corrections are relatively easy to consider, the main properties of the isotopes can

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Some Isotopes of Light Nuclei

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be determined with Z> N from the known properties of the isotopes with N> Z. Fig. 1 gives a scheme of the difference of the binding energy of the Z-th neutrons in the nucleus (A,A-Z) and the binding energy of the Z-th proton in the nucleus (A,Z). In a similar scheme Fig. 3 illustrates the region of the stable nuclei. The most promising method of producing neutron-deficient isotopes of light nuclei are the reactions (p,xn) and (He^3,xn), as well as reactions induced by multiply-charged ion bombardment. New physical phenomena are assumed to be observable in neutron-deficient nuclei, proton and two-proton radioactivity; these phenomena are dealt with in part 3 of the paper in which among others the region where such phenomena may occur, is briefly outlined, and the main properties of two-proton radioactivity are described. The reaction $Ne^{16} \rightarrow O^{14} + 2p$ is discussed more thoroughly. $Mg^{17(18?)}$, $Si^{21(22?)}$, $S^{25(24?)}$, $Al^{29(28?)}$, $Ca^{33(34?)}$, Ti^{48}, Cr^{42}, $Fe^{44(43?)}$, $Ni^{46(47?)}$, $Zn^{53(54?)}$, $Ge^{59(58?)}$, $Se^{63(62?)}$, $Kr^{67(66?)}$, are also counted among the 2p-active nuclei. In part 4 the nuclei

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with high neutron excess are dealt with. In this case above all problems of neutron binding energy in the nucleus are discussed (Fig. 6 shows E_n as a function of Z for a large number of N-values). Also experimental results are presented and discussed. The possibilities of an experimental determination of the bineutron (reaction (n^2,α) e.g. $N^{14} + n^2 \rightarrow B^{12} + \alpha + 3.2$ Mev, $n^2 \rightarrow 2n$ decay on passage of n^2 through matter and measurement of the neutron directional correlation, Fig.7) are discussed. Furthermore experiments for determining H^5 and He^8 are discussed. In part 5 considerations are made on the stability limits and a five-page table containing a survey of various properties $(N, A, (M-A), E_p, E_n, E_\beta, T_{1/2\beta})$ of isotopes with neutron excess as well as of neutron- deficient electrons for the region $2 \leq Z \leq 40$ is given which is highly valuable for practical work in this field. P. E. Nemirovskiy and A. T. Varfolomeyev are mentioned. There are 8 figures, 1 table, and 25 references: 14 Soviet, 10 US, and 1 Canadian.

BAZ', A.I.; GOL'DANSKIY, V.I.; ZEL'DOVICH, Ya.B.

Undiscovered isotopes of light nuclei. Usp. fiz. nauk 77 no.2:211-234 O '60. (MIRA 16:8)

(Isotopes)

ZEL'DOVICH, Ya. B., Dr.,

"Theory of the detonation and formation of abnormal shock waves for which the Chapman-Jonguet conditions are not effective."

"Emission of light by shock waves and their structure."

To be submitted for the Scientific Research, National Center of-International Colloquium on Detonation Waves- Gif-sur-Yvette (Seine-et-Oise), France, 28Aug-2 Sep 1961.

Institute of Chemical Physics, Academy of Sciences USSR.

30917
S/195/61/002/003/001/009
E030/E111

11.6200 (also 3619)

AUTHOR: Zel'dovich, Ya.B.

TITLE: Chain reactions in burning flames - an approximate theory of flame velocity

PERIODICAL: Kinetika i kataliz, v.2, no.3, 1961, 305-318

TEXT: This article was presented at the All-Union Conference on Combustion, January 10, 1961.
The test theories hitherto have led to exact differential equations which can be solved, in general, only by numerical integration for each case. Here, a series of approximate theories are developed for each type of flame, and these are used to give physical insight into the process and to provide interpolation formulae for regions intermediate between those for which exact formulae exist. All are based on the relations from heat theory,

$$T_b - T \sim RT_b^2/Q$$

where T_b is the temperature of burning and Q the activation energy, and the Michelson relation for the distribution of temperature by diffusion in the reaction zone:

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$$T = T_o + (T_b - T_o) \cdot e^{xu/D} \qquad (1)$$

where: x is spatial coordinate, T_o initial temperature, u burning velocity, D thermal diffusion coefficient. The reaction velocities are introduced from the kinetics of the processes, and by using the Frank-Kamenetskiy integration method Ref.7: D.A. Frank-Kamenetskiy, Diffusion and Heat Transfer in Chemical Kinetics, Izd-vo AN SSSR, 1947) one obtains the quantity of substance in the reaction zone, and the burning velocity. The four considered cases are as follows: 1) Unbranched chain reaction, in which the forming of active centres does not continue in the products of burning (it stops in the reaction zone). In this case the formula for burning velocity given by the expression

$$u = \sqrt{Dke^{-Q/RT_b}\alpha^2} \qquad (8)$$

is identical with that of Spalding (Ref.5: Spalding, Phil. Trans. Roy. Soc. v.249, 957, 1956) apart from $\sqrt{2}$ which must therefore be introduced as a multiplier in all the subsequent approximations.

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Chain reactions in burning flames - ...

2) Unbranched chain reaction with excess of substance forming active centres, in which case the forming of active centres continues in the products of burning. Let A be the initial substance, B the active centres, and X any reacting molecule; then

$$A + X = 2B + X \qquad (9)$$

The transformation of A into end-product C is given by the reaction:

$$A + B = C + B \qquad (11)$$

and depends on B. For a flame velocity dependent on activation energy according to Arrhenius,

$$u^4 = D^2 A_o X k_1 k_2 e^{-(Q_1 + Q_2)/RT_b} \quad 2\alpha_1^2 \alpha_2^2 \qquad (18)$$

agreeing again with Spalding, but for $\sqrt{2}$, and giving velocity independent of pressure. However, for excess of B, u varies as

$$pe^{-(Q_1+Q_2)/4RT_b}$$

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3) Branched chain, no sharp edge to reaction. Also in this case the velocity u is independent of pressure; it depends only on the kinetics of development of the chains, and not on the kinetics of the reaction of transformation of the initial substance in the final one by activity of the centres. In connection with the experiments of S.Ya. Pshezhetskiy and his team (Ref.11: V.L. Cheredinchenko, I.N. Pospelova, S.Ya. Pshezhetskiy, Zh. fiz. khimii, v.32, 2674, 1958) the influence of the initial concentration of active centres was considered. Normally the concentration of active centres may be small. If this is called B_o and the flame velocity u_1, then if further active centres are introduced - by ionization, say - up to quantity B_m actually in the reaction zone, one obtains a flame velocity u', and the expression

$$\left(\frac{u}{u'}\right)^2 = 1 + \frac{B_o}{B'_m} \tag{41}$$

As the quantity of active centres introduced is known, the important quantity B_m may be measured, i.e. the concentration of centres at which under real conditions ($B_o = 0$) the reaction in

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Chain reactions in burning flames - ...

the flame arises.
4) Highly branched reaction, in which recombination of centres is principally responsible for evolution of heat. For strong recombination (under high pressure and low burning temperature), u varies as $(rX)^{-1/4}$, where r is the recombination constant.
For weak recombination,

$$u^2 = h\ A_o Dr\ X \qquad (73)$$

where h is a dimensionless number.

Ackhowledgments are expressed to G.I. Barenblatt and V.I. Kondrat'yev for their interest in the work.

There are 4 figures and 11 references: 9 Soviet-bloc and 2 non-Soviet-bloc. The English language reference reads as follows:
Ref.5: Spalding, Phil. Trans. Roy. Soc., v.249, 957, 1956.

ASSOCIATION: Institut khimicheskoy fiziki AN SSSR
(Institute of Chemical Physics, AS USSR)

SUBMITTED: February 4, 1961

Card 5/5

ZEL'DOVICH, Ya.B.

Symmetric composite model of strongly interacting elementary particles. Zhur. eksp. i teor. fiz. 40 no.1.319-323 Ja '61.
(MIRA 14:6)

(Particles (Nuclear physics))

S/056/61/040/002/037/047
B112/B214

AUTHOR: Zel'dovich, Ya. B.

TITLE: Theory of fermion masses

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v.40, no. 2, 1961, 637-640

TEXT: The particle mass can be determined from the interaction of the particle with dissimilar or similar particles. The resulting mass of the particle may in general also come out to be infinite. In order to obtain a finite mass, it is necessary to subject the interaction formulation to important limitations. A theory of the fermion mass is discussed in the present paper. It is based on Dirac's equation for a particle of nonvanishing rest mass. The four-dimensional state vector (wave function) breaks up into two two-dimensional spin vectors $\psi = \binom{\varphi}{\dot{\chi}}$.

For a vanishing rest mass of the particle, Dirac's equation is reduced to two independent equations for φ and $\dot{\chi}$ which describe the motion of

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Theory of fermion masses

S/056/61/040/002/037/047
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a system of particles with oppositely directed spin orientations ("right particles" with spin+1/2 and "left particles" with spin -1/2). In the general case, the mass appears as a factor in the Lagrange operator and characterizes the relationship between the "right" and "left" particles. Particles of finite mass may be considered to be superpositions of "left" and "right" particles. The case of an interaction is considered which can be schematically characterized by the symbols $(\psi^* \psi^* \psi \psi)$, $(\psi^* \psi \psi \psi)$, $(\psi^* \psi^* \psi^* \psi)$. It is found that the mass of a given particle with the wave functions φ, $\dot{\chi}$ appears in the result of four-fermion interaction only when the particle enters the interaction in a two-fold way by means of φ and $\dot{\chi}$. This result is in contradiction with a principle of M. Gell-Mann and R. P. Feynman, due to the fact that the particle possesses a polarization different from v/c. L. D. Landau, B. L. Ioffe, L. B. Okun', and I. Ya. Pomeranchuk are thanked for discussions. There are 2 figures and 7 references: 1 Soviet-bloc and 3 non-Soviet-bloc.

SUBMITTED: September 3, 1960 (initially)
(November 11, 1960 (after revision)

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ZEL'DOVICH, Ya.B.

Unstable particle in the Lee model. Zhur. eksp. i teor. fiz. 40 no.4:1155-1159 Ap '61. (MIRA 14:7)
(Nuclear models) (Quantum theory)

GRIBOV, V.N.; ZEL'DOVICH, Ya.B.; PERELOMOV, A.M.

Maximum charge for a given mass in the bound state. Zhur. eksp. i teor. fiz. 40 no.4:1190-1198 Ap '61. (MIRA 14:7)
(Nuclear reactions) (Particles (Nuclear physics))

28763
S/056/61/041/003/016/020
B125/102

24.6610 (1057, 1538)

AUTHORS: Zel'dovich, Ya. B., Smorodinskiy, Ya. A.

TITLE: The upper limit of neutrino, graviton, and baryon density in the universe

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 3(9), 1961, 907-911

TEXT: To estimate the maximum energy density of neutrinos, gravitons and baryons in the universe the gravitational effect of these particles on the expanding universe has been investigated by the authors. According to B. M. Pontekorvo and Ya. A. Smorodinskiy (ZhETF, 41, 239, 1961) it is very difficult to determine the cosmic neutrino density. Direct tests have shown that the mass-energy density in the form of neutrinos may be 10^4 to 10^5 times higher than the rest-mass-energy density in an ordinary form. The authors, and also F. Reines, have already shown that these estimates depend on hypotheses concerning the neutrino spectrum. Another method for calculating the maximum energy density is based on determining the gravitational effect and fits all unknown, weakly interacting fields, also

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The upper limit of neutrino ...

for the density of high-frequency oscillations of the gravitational field (gravitons). According to G. M. Gandel'man and V. S. Pinayev (ZhETF, 37, 1072, 1959), the bremsstrahlung of gravitons is 10^{10} times smaller than the radiation of $\nu - \bar{\nu}$ pairs. For the suggested estimate, the density ϱ of all kinds of matter-energy determines the past of the universe. The critical density ϱ_k of the matter-energy, which has been introduced by the authors, characterizes the transition from an open to a closed model of the universe: at $\varrho < \varrho_k$, the expansion will last for an unlimited time; at $\varrho > \varrho_k$, however, this expansion will change over into contraction. The times T counted from the instant of maximum density of the universum until now are as follows:

$$\tau = k^{-2}[(k + k^{-1})\,\mathrm{arctg}\,k - 1], \qquad k = (2q - 1)^{1/2};$$

$$\tau' = [1 + (2q)^{1/2}]^{-1}.$$

$q = \varrho/2\varrho_k$; τ is calculated for resting matter and a pressure $p = 0$; τ' is calculated according to L. D. Landau for negligible rest mass, i.e., for particles moving at velocity of light and $p = \mathcal{E}/3$ ($\mathcal{E}$ denotes the energy

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The upper limit of neutrino ...

density). For $T_o = 10^{10}$ years, one obtains $\tau > 0.4$ and, therefrom, $q < 5$ and $\varrho < 2 \cdot 10^{-28}$ g/cm^3. An independent investigation yields $q < 10$ for distant galactics systems. Equal results are obtained in a third estimate of the maximum density by studying the star density in the galaxies. It is possible that the density of neutrinos, gravitons, etc., in the universe is higher than the mean nucleon density observed (10^{-29} g/cm^3) but more than 10 to 20 times. The similarity of $\varrho = 10^{-29}$ g/cm^3 for ordinary matter suggested a comparatively young age of the universe. At equal order of magnitude of neutrino mass and nucleon mass densities, the value for the density will be smaller than $\sim 10^{-29}$ g/cm^3, and correspond to $\sim 10^{-5}$ nucleons per cm^3. The number of nucleons may be much larger than the given value since the gravitational mass defect ΔM of a star after the gravitational collapse may be of the same order of magnitude as the sum of the rest masses of the nucleons contained in the star. At present, there is no correct theory on gravitational collapses. L. D. Landau and Ye. M. Lifshits have estimated the critical mass to be 76% of the solar mass. When a gravitational collapse of a star occurs, the energy might be emitted in the form of neutrinos and antineutrinos. The mean nucleon

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The upper limit of neutrino ...

density in collapsed stars will be no more than 10 to 20 times higher than known densities of ordinary nucleons. All these estimates are only correct for not too early collapses. There are 15 references: 9 Soviet and 6 non-Soviet. The four most recent references to English-language publications read as follows: F. Reines, C. L. Cowan, Jr., F. B. Harrison, A. D. Mc. Cuire, H. W. Kruse, Phys. Rev., 117, 159, 1960; H. Y. Chin, P. Morrison. Phys. Rev. Lett., 5, 573, 1960. M. Gell-Mann. Phys. Rev. Lett. 6, 70, 1961. F. Hoyle. Proc. Phys. Soc. 77, 1, 1961.

SUBMITTED: April 14, 1961

Card 4/4

ZEL'DOVICH, Ya.B.

Correlation of electron and positron polarization in relativistic pairs. Zhur.eksp.i teor.fiz. 41 no.3:912-913 S '61. (MIRA 14:10)
(Electrons) (Positrons)

26711
S/056/61/041/005/026/038
B102/B138

3,1900 (1057, 1538, 3717)

AUTHOR: Zel'dovich, Ya. B.

TITLE: Equation of state at ultra-high densities and its relativistic limitations

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 5(11), 1961, 1609-1615

TEXT: The author develops a relativistically invariant theory to describe the state of heavy stars after gravitational collapse. The theory of neutron condensation (L. D. Landau, Zs. Sow. Phys., 1, 285, 1932) and the approximation of rigid nucleon repulsion lead to results which are in contradiction to the theory of relativity. From special relativity the inequality $3p \leq \varepsilon$ results, where p is the pressure and ε the energy density which includes the particle's rest mass. ($3p < \varepsilon$ for free non-interacting particles, $3p = \varepsilon$ for an electromagnetic field). In the theory proposed here $3p > \varepsilon$ is possible and $p = \varepsilon$ is the limit. As an example, a classical vector field with mass, interacting with classical point charges at rest, is considered. For

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$$L = -\frac{1}{16\pi} F_{ik}^2 - \frac{1}{8\pi}\mu^2 A_k^2, \qquad S_l = i\int L d^4 x, \tag{2.1}$$

$$\partial A_k / \partial x_k = 0, \qquad F_{ik} = \partial A_k / \partial x_i - \partial A_i / \partial x_k. \tag{2.2}$$

(with $c = 1$ and the metric $A_k^2 = A^2 + A_4^2$, $A_4 = iA_0 = i\varphi$, $m = \mu\hbar$, the mass of the field quantum) the field equation

$$\frac{\partial F_{ik}}{\partial x_k} = -\sum_k \frac{\partial^2 A_i}{\partial x_k^2} = -\mu^2 A_i + 4\pi j_i. \tag{2.4}$$

is found; its solution is $\varphi = ge^{-\mu r}/r$, $\vec{A} = 0$. The interaction energy of two charges is given by $g\varphi_{r_1}(r_2) = g^2 e^{\mu r_{12}}/r_{12}$, energy and pressure by

$$\varepsilon = nE_1 = Mn + 2\pi g^2 n^2/\mu^2 \tag{3.5}$$

$$p = -\partial E_1/\partial(1/n) = 2\pi g^2 n^2/\mu^2 \tag{3.6}.$$

From this it can be seen that for large densities, n, $p \to \varepsilon$. For a meson mass m much less than the baryon mass M the coupling constant is in the range

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$\hbar c(m/M)^2 < g^2 < \hbar c(M/m)$. A state with $3p > \varepsilon$ can be realized for a density for which the characteristic length $1/\mu$ and the distance to the nearest neighbor, $n^{-1/3}$, exceed the classical baryon radius g^2/Mc^2 and the Compton wave length $\hbar/Mc$ of the baryon. The possibility of $3p > \varepsilon$ is not related to any extrapolation. The stress tensor with the components $T_{44} = -\varepsilon$, $T_{xx} = T_{yy} = T_{zz} = p$ can be determined from $T_{ik} = L\delta_{ik} - \frac{\partial A_l}{\partial x_i} \frac{\partial L}{\partial(\partial A_l/\partial x_k)}$ and

$$\varepsilon = -T_{44} = [E^2 + H^2 + \mu^2 (A^2 + \varphi^2)/8\pi]/8\pi, \qquad (4.3)$$

$$3p = T_{xx} + T_{yy} + T_{zz} = (E^2 + H^2)/8\pi + \mu^2 (3\varphi^2 - A^2)/8\pi. \qquad (4.4)$$

is found. For a large system $(|\Delta\varphi| \ll \mu^2\varphi)$

$$\varphi = 4\pi gn/\mu^2, \quad \varepsilon = 2\pi g^2 n^2/\mu^2, \quad 3p = 6\pi g^2 n^2/\mu^2 \qquad (4.6)$$

holds and for $\varepsilon_p = Mn$: $p \to \varepsilon$, $3p > \varepsilon$ for $n > \mu^2 M/4\pi g^2$, $\varphi > M$. If the domain considered is free from charges $\varepsilon - 3p = \mu^2(A^2 - \varphi^2)/4\pi$, $\omega^2 = k^2 + \mu^2$ and $\omega_k \varphi_k = \vec{a}_k \vec{k}$, i.e. $|\varphi_k| < |\vec{a}_k|$ and $\varepsilon > 3p$. Going over to electrodynamics

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$3\bar{p} < \bar{\varepsilon}$ is found for a Coulomb field. For $\mu < 1/R$ (R - size of the system)

$$\varphi \sim R^2 gn, \quad \varepsilon\varphi \sim \mu^2 \varphi^2 \sim \mu^2 R^4 g^2 n^2 \qquad (5.4)$$

holds, and for $\mu \gg 1/R$: $3p = \varepsilon$. Finally the problem of the reality of a model of charges at rest is discussed. The most rigid equation of state consistent with relativity, $p = \varepsilon \sim n^2$, is realized for baryon interaction via a vector field with non-vanishing mass (c.f. Yu. I. Kobzarev and L. B. Okun', ZhETF, 41, 499, 1961). For $g^2/\hbar = 1$ and $m = \hbar\mu = M/2$ and equal g values for the baryons n, p and Λ, $3p = \varepsilon$ where the density $n_c = \mu^2 M/4\pi g^2 = M^4 c^3/16\pi\hbar^3$ which corresponds to a nearest neighbor distance of $r_{c(ik)} = 4\hbar/Mc = 2/\mu \approx 0.8\,\phi$. This n_c value is 20 times greater than the nuclear density corresponding to the radius $R = 1.2A^{1/3}\phi$ of a heavy nucleus. By estimating the quantum corrections the energy of the free Fermi gas for three types of independent particles can be approximated by $\varepsilon = 2aN\sqrt{1 + 0.2N^{2/3}} \rightarrow 0.9\,aN^{4/3}$, $N \gg 1$. The paper was discussed in April 1961

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Equation of state at ultra-high...

in Nor-Amberd at a physics school organized by the Institut fiziki AN Armyanskoy SSR (Institute of Physics AS Armyanskaya SSR). The author thanks G. S. Saakyan for discussions. There are 10 references: 7 Soviet and 3 non-Soviet. The two references to English-language publications read as follows: A. G. W. Cameron. Astroph. J., 130, 884, 1959; E. E. Salpeter. Ann. of Phys. 11, 393, 1960.

SUBMITTED: May 31, 1961

Card 5/5

25335

S/020/61/138/006/011/019
B104/B214

24,3950 also 2108

AUTHORS: Zel'dovich, Ya. B., Academician, Kormer, S. B., Sinitsyn, M. V., and Yushko, K. B.

TITLE: An investigation of the optical properties of transparent substances at superhigh pressures

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 138, no. 6, 1961 1333 - 1336

TEXT: The propagation of strong shock waves in transparent media permits to study the properties of substances at pressures of some thousands or millions of atmospheres (Zel'dovich et al., DAN 122, no. 1, 48(1958)). At pressures not too high if the compressed substance remains transparent throughout its thickness the refractive index may be determined geometrically. The authors first studied water, plexiglass, and glass. A diagram of the experimental set-up with which the reflection of light by the shock wave can be determined, is shown in Fig. 1. The reflected rays II - V were recorded by a fast photochronograph. Water was found to remain transparent under pressures of 89 - 144 thousand atmospheres. Glass becomes opaque at a pressure of 200,000 atmospheres. The exact values

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An investigation of the optical...

for water are collected in Table 1. In the discussion of the results the authors used the data of V. Raman and K. S. Venktaraman (Proc. Roy. Soc., 171, 137 (1939)) and gave the following relation for the temperature and density dependence of the refractive index: $n = 1.334 + 0.334(\rho - 1) - 1.90 \cdot 10^{-5} T \rho$ (1), T being in °C. Fig. 5 shows graphically a comparison of the values of n calculated by (1) with those determined by geometrical methods. The dotted line in this diagram corresponds to the Lorentz - Lorenz formula. The deviations of the results obtained photometrically can be partly explained by the increase in viscosity of water at high pressure. L. V. Al'tshuler (Ref. 6) had detected a decrease of the intensity of the reflected light at pressures above 115,000 atm and shown it to be related to the phase transformation at this pressure. This effect could not be detected by the present authors. They are of the opinion that water remains transparent up to 300,000 atm. A. G. Oleynik, V. N. Mineyev, and R. M. Zaydel' are mentioned. The authors thank V. P. Arzhanov, G. V. Krishkevich for carrying out the experiments and A. G. Ivanov, R. M. Zaydel', A. G. Oleynik, and V. N. Mineyev for valuable discussions. There are 3 figures, 1 table, and 10 references: 5 Soviet-

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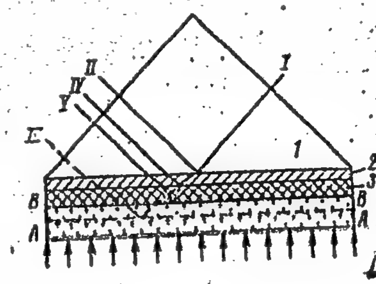
bloc, and 5 non-Soviet-bloc.

SUBMITTED: March 30, 1961

Fig. 1: Experimental set-up.



Legend: I) incident ray. II) and III) light reflected from the stationary boundary between plexiglass and water. IV) light reflected from the front of the shock wave. V) light reflected from the moving boundary between compressed water and compressed plexiglass. 1) plexiglass prism. 2) water in front of the shock wave front. 3) water compressed in the shock wave.

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25849
S/020/61/139/004/009/025
B104/B209

5.4130

AUTHOR: Zel'dovich, Ya. B., Academician

TITLE: Molecular symmetry, melting of a crystal, and structure of liquids

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 139, no. 4, 1961, 841-843

TEXT: The author studied the effect of molecular symmetry upon the melting process of crystals and on the orderly structure of liquids. It is pointed out that the higher the symmetry of a molecule the better will this molecule fit into a crystal lattice. Moreover, the symmetry of the molecules exerts a noticeable influence on the melting point of a crystal, which is due to the thermal agitation since the latter depends on this symmetry. In particular, the author studied the three isomers of $C_6H_4Cl_2$ (ortho, meta, and para-chlorobenzene). Among these, para-chlorobenzene has the highest symmetry, and therefore also the highest melting point (+52.5°C). The symmetries in meta-chlorobenzene (-24.4°C) and in ortho-chlorobenzene (-17.5°C) are lower. This situation is considered to be characteristic of many organic compounds. However, there are also exceptions to this rule

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Molecular symmetry, melting of ...

that are due to the effect of lattice energy. Thus, for instance, the α- and the β-derivatives of naphthalene have the same symmetry but different melting points. The theoretical treatment is based on the assumption that the molecules in the crystal are arranged and aligned regularly. The entropy of the crystal at absolute zero is assumed to vanish. The intermolecular spacings in liquids are of the same order of magnitude as those in crystals, but there is no mutual alignment of the molecules in the former case. For this reason, molecular interaction in a liquid greatly affects the translatory motion, the rotary motion, however, only slightly. This fact is accomplished by the elementary concept of the molecules vibrating in a crystal, revolving in a liquid, and performing a rotary as well as a Brownian movement in a gas. It is stated that the entropy of a crystal does not depend on the symmetry of its molecules. The relation $S_{liqu}(T) = s_o(T) - R \ln n$ is given for the entropy of a liquid; n denotes the so-called symmetry number of the molecules. The melting temperature is given by $\Delta T = RT^2_{melt} \Delta \ln n/Q_f$, where Q_f is the heat of fusion. A difference of 30^oC in the melting temperatures of para-chlorobenzene and meta- and

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Molecular symmetry, melting of ...

ortho-chlorobenzene (the melting points of the two last are assumed to be equal) is obtained by means of the above formula. In experiments, a difference of 73°C was determined. Moreover, the experiments proved that $T_{meta} - T_{ortho} = -7°C$. The author points out that the molecular symmetry in liquids does not permit a free rotation of the molecules. The molecules rather perform rotational vibrations with rare jumps from one alignment to the other. A very weak effect of symmetry is possible in two cases: 1) When the crystal is not completely regular. This is the case when physically slightly different groups determining the crystal symmetry are substituted (e.g. hydrogen by deuterium). The entropy in this case does not vanish at absolute zero but depends on the symmetry of the molecules. 2) When the liquid retains a certain orderliness of alignment at the melting point. The author thanks A. V. Shubnikov and A. I. Kitaygorodskiy for their remarks. There is 1 figure.

SUBMITTED: April 26, 1961

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S/020/61/140/006/009/030
B104/B102

AUTHORS: Zel'dovich, Ya. B., Academician, Barenblatt, G. I., and Salganik, R. L.

TITLE: Quasi-periodic precipitations during mutual diffusion of two substances (Lisegang rings)

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 140, no. 6, 1961, 1281 - 1284

TEXT: During mutual diffusion of two reacting substances insoluble precipitates fall out in so-called Lisegang rings. The most probable formation of Lisegang rings is described as follows: During diffusion the solution is supersaturated as long as the product ab of the concentrations a and b of the substances A and B does not reach a critical value k (metastable limit). As ab exceeds k at a given point, one of the reaction components is precipitated completely. Due to diffusion, a new portion of this component enters the impoverished region and the precipitation mechanism appears again. If the region of precipitations does not propagate too fast, the following precipitation is somewhat distant from the pre-

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vious one. In the present paper, an approximation of the formation of Lisegang rings during diffusion of substances in a cylindrical tube is given. The authors derive a and b as functions of the reduced parameter $\xi = x/x_n$, where x is the coordinate of the axis of the tube, and x_n is the coordinate of the n-th precipitation. For sufficiently high n the distributions of a and b within the ranges $1 < \xi < \infty$ and $1 < \tau < \gamma$ ($\tau = t/t_n$) depend on $c = a_o/b_o$ (a_o and b_o are the concentrations before diffusion starts), $\varkappa = k/a_o b_o$ and $\alpha^2 = D_a/D_b$ (D_a and D_b are the diffusion coefficients of the substances A and B). The distributions do not depend on n. Under this condition of quasi-periodicity the distributions of a and b as functions of $\mu = x_{n+1}/x_n$, $\gamma = t_{n+1}/t_n$, $\eta = \sqrt{D_a t_{n+1}}/x_{n+1}$, μ, c and $\varkappa$ are studied. The results allow the metastable limit k to be experimentally determined. The authors thank L. Ya. Semenova for calculations. There are 2 figures and 3 Soviet references.

ASSOCIATION: Institut mekhaniki Moskovskogo gosudarstvennogo universiteta im. M. V. Lomonosova (Institute of Mechanics of Moscow State University imeni M. V. Lomonosov)

Card 2/2

BARENBLATT, G.I. (Moskva); ZEL'DOVICH, Ya.B. (Moskva); ISTRATOV, A.G. (Moskva)

Diffusion heat stability of a laminar flame. PMTF no.4:21-26 Jl-Ag '62. (MIRA 16:1)

(Flame)

ZAYDEL', R.M. (Moskva); ZEL'DOVICH, Ya.B. (Moskva)

Possible conditions of stationary combustion. PMTF no.4:27-32 Jl-Ag '62. (MIRA 16:1)

(Combustion)

34656

S/056/62/042/002/053/055
B108/B138

24.4600

AUTHOR: Zel'dovich, Ya. B.

TITLE: Collapse of small mass in general relativity theory

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 641-643

TEXT: According to J. R. Oppenheimer and G. M. Volkoff (Phys. Rev., 55, 374, 1939) the one solution of the equilibrium of a cold ideal Fermi gas which exists at small neutron number ($N < 0.35N_s$, N_s - number of nucleons in the sun) is absolutely stable and a collapse at such N is not possible. Nevertheless, this is not the case. A configuration with sufficiently high density and arbitrary N, whose mass is as near to zero as required and smaller than the mass of the static solution, cannot go over into equilibrium (static solution), and consequently can only infinitely contract:

$$N = \text{const}\, a^{3/4} R^{3/2} \sqrt{1 - ab}, \tag{9}$$

$$R = \text{const}\, N^{2/3} a^{-1/2} (1 - ab)^{1/3}, \quad M = \text{const}\, N^{2/3} a^{1/2} (1 - ab)^{1/3}.$$

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Collapse of small mass in ... S/056/62/042/002/053/055
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This shows that $M \rightarrow 0$ at $a \rightarrow 1/b$ for any N. For an estimate of the energy barrier separating the equilibrium solution with $M \leq Nm$ (m - mass of the neutron) from the collapsing state the maximum M is found from the above equation: $M_{max} \sim N^{2/3}\sqrt{\hbar/k}$. This shows that collapse is possible also for systems consisting of a small number of nucleons, but the barrier exceeds the initial energy of the system at rest many times. N. A. Dmitriyev, L. D. Landau, Ye. M. Lifshits, and S. Kholin are thanked for discussions. There are 4 references: 3 Soviet and 1 non-Soviet.

SUBMITTED: December 15, 1961

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38871
S/056/62/042/006/039/047
B104/B112

24.4600

AUTHOR: Zel'dovich, Ya. B.

TITLE: Static solutions with energy excess in the general theory of relativity

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 6, 1962, 1667-1671

TEXT: If there is only gravitational interaction between particles of a Fermi gas, then each particle performs a finite motion in the gravitational field of the other particles of the system. The trajectory lies in a plane passing through the center of the system which is regarded as a star. For the radial coordinate one finds $r_1 < r < r_2$. The total energy of the particle remains conserved during its motion and is less than mc^2. The total energy of the entire system, however, is greater than Nmc^2 (N = number of particles). The conditions under which this situation arises when solving the equation of motion and the limitations to be imposed on the ratio of the total energy of the system to the rest energy of the

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Static solutions with energy excess ... S/056/62/042/006/039/047
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individual particles are examined. This solution is shown to be purely relativistic. The principle of the mass extremum is formulated, and it is shown that the derivative of the stellar mass with respect to the number of particles is less than the rest mass of the particles. The existence of the solution indicated is related to an ambiguous dependence of the mass on the number of particles. There are 2 figures.

ASSOCIATION: Institut teoreticheskoy i eksperimental'noy fiziki (Institute of Theoretical and Experimental Physics)

SUBMITTED: February 9, 1962

S/056/62/043/003/045/063
B108/B102

AUTHOR: Zel'dovich, Ya. B.

TITLE: Semi-closed worlds in general relativity

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 3(9), 1962, 1037 - 1043

TEXT: The spherically symmetric part of an isotropic Friedmann world is considered. The greater the Friedmann part considered, the smaller is the junction between this spherically symmetric part, of constant density, and empty space (Schwartzschild solution). Such a part is termed a semi-closed world. Its circumference, area, and mass pass through maxima as the distance from the center increases. The outer radius of the semi-closed world is greater than the gravitational radius corresponding to its mass. Therefore, within finite time of that world, an exchange of matter, energy, or information with the surrounding empty space is not possible. There are 2 figures.

ASSOCIATION: Institut teoreticheskoy i eksperimental'noy fiziki Akademii nauk SSSR (Institute of Theoretical and Experimental Physics of the Academy of Sciences USSR)

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S/056/62/043/004/059/061
B104/B186

AUTHOR: Zel'dovich, Ya. B.

TITLE: The state of matter before the formation of stars

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 4(10), 1962, 1561-1562

TEXT: The state of matter at the beginning of evolution is studied. It is assumed that matter then comprised equal quantities of protons, electrons, and neutrinos, and that entropy was low. At high densities (in the region of nuclear density) and at zero temperature, neutrinos and electrons constitute a degenerate relativistic. Fermi gas. By reason of their chirality, the neutrinos possess greater Fermi energy E_{F_ν} than the electrons. At a density of $2.5 \cdot 10^{38}$ particles/cm^3, E_{F_ν} = 500 Mev, E_{F_e} = 400 Mev. The process $e^- + p \rightarrow n + \nu$, which in stellar matter of high density leads to the formation of neutrons, appears to be forbidden

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here by reasons relating to the neutrino state. Cold hydrogen forms when such a matter expands. The heavy elements that have formed the stars are likely to have formed from hydrogen in nuclear reactions. G. Gamov (Rev. Mod. Phys., 21, 367, 1949), R. Alpher and R. Herman (Rev. Mod. Phys., 22, 153, 1950; Ann. Rev. Nucl. Sci., 2, 1, 1953) and C. Hayashi (Progr. Theor. Phys., 5, 224, 1950) have assumed that matter in its initial state consisted of neutrons or of approximately equal quantities of neutrons and protons, and that its temperature was very high. From this it would follow that the matter before the formation of stars contained amounts of 10-20% He and about 0.5% deuterium. The radiation density (energy/c^2) remained about equal to the nucleon density after the expansion of matter to the present mean density of 10^{-30} g/cm^3. These results appear to be inconsistent with observations, and therefore the concept of matter consisting of protons, electrons, and neutrinos is the only possible one. At densities for which the Fermi energy of the protons is commensurable with their rest mass, neutrons and hyperons can be produced in different processes. Expansion, however, proceeds slowly as compared with the relaxation time of these processes, and when the density of nuclear matter was reached, only p, e^- and ν were left over.

The state of matter before ...

S/056/62/043/004/059/061
B104/B186

ASSOCIATION: Institūt teoreticheskoy i eksperimental'noy fiziki Akademii nauk SSSR (Institute of Theoretical and Experimental Physics of the Academy of Sciences USSR)

SUBMITTED: August 31, 1962

Card 3/3

ZEL'DOVICH, Ya.B.

Formation of stars in an expanding universe. Zhur. eksp. i teor. fiz. 43 no.5:1982-1984 N '62. (MIRA 15:12)
(Cosmogony)

ZEL'DOVICH, Ya.B., akademik (Moskva)

Encyclopedia of theoretical physics. Priroda 51 no.7:58-60 Jl '62. (MIRA 15:9)

(Physics) (Landau, Lev Davidovich, 1908)
(Lifshits, Evgenii Mikhailovich)

S/053/62/078/004/001/004
B164/B102

AUTHOR: Zel'dovich, Ya. B.

TITLE: Problems of modern physics and astronomy

PERIODICAL: Uspekhi fizicheskikh nauk, v. 78, no. 4, 1962, 549 - 578

TEXT: This revised version of an introductory review presented at the School for Astrophysics in Tartu deals with the present state (1949 - 62) of the physics of elementary particles and the theory of gravitation. Separate chapters are devoted to conservation theorems in interaction of elementary particles; antiparticles; classical interaction and strangeness; three-particle model; electromagnetic interaction; baryon interaction; neutrino theory; fermion mass; weak interaction and β-decay; unsolved problems in the theory of weak interaction; supernew particles and new ways to the particle theory; table of particles; gravitational interaction, general relativity and gravitational quanta; spontaneous generation of matter; variability of constants. There are 2 tables and 104 references.

Card 1/1

ZEL'DOVICH, Yakov Borisovich; RIVIN, Mikhail Abramovich[deceased]; FRANK-KAMENETSKIY, David Al'bertovich; LEYPUNSKIY, O.I., doktor fiz.-mat. nauk, prof., red.; BOGOMOLOVA, M.F., red.izd-va; SKOTNIKOVA, N.N., tekhn. red.

[Jet-power impulse of powder rockets]Impul's reaktivnoi sily porokhovykh raket. Moskva, Oborongiz, 1963. 189 p. (MIRA 16:3)

(Solid propellant rockets) (Jet propulsion)

ZEL'DOVICH, Yakov Borisovich, akademik; SEMENDYAYEV,K.A.,red.;NORKIN,S.B., red.; KOLESNIKOVA, A.P., tekhn. red.

[Higher mathematics for beginners and its applications to physics] Vysshaia matematika dlia nachinaiushchikh i ee prilozheniia k fizike. Izd.2., perer. i dop. Moskva, Fizmatgiz, 1963. 559 p. (MIRA 16:4)

(Mathematics)

AM4026342 BOOK EXPLOITATION S/

Zel'dovich, YAkov Borisovich; Rayzer, YUriy Petrovich

Physics of shock waves and high-temperature hydrodynamic phenomena (Fizika udarny*kh voln i vy*sokotemperaturny*kh gidrodinamicheskikh yavleniy). Moscow, Fizmatgiz, 63. 0632 p. illus., biblio. 4,000 copies printed.

TOPIC TAGS: gas dynamics, shock waves, heat transport, thermal radiation, radiant heat exchange, thermodynamic properties of gas, high temperature properties, shock tube, relaxation processes, shock wave front, ionization, molecular gas, plasma, thermal waves, self-similar processes

PURPOSE AND COVERAGE: This is claimed to be the first book in the world literature devoted to a systematic analysis of many problems on different branches of physics, physical chemistry, and astrophysics in which modern gas dynamics and hydrodynamics are involved.

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It deals with the principles of gas dynamics and the theory of shock waves, the theory of radiative transfer, the thermodynamic and optical properties of matter at high temperatures and pressures, dissociation kinetics, ionization, and other nonequilibrium processes, as well as phenomena connected with the radiation of light and radiant heat exchange in shock waves and in explosions and problems involved in the propagation of shock waves in solids, etc. The book reflects the authors' many original papers in this field. The book will serve as a valuable practical text for many physicists, mechanics, specialists, engineers and undergraduate and graduate students specializing in applied physics and modern engineering, or those who wish to become acquainted with the present status of the science of shock waves.

TABLE OF CONTENTS [abridged]:

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SUB CODE: PH SUBMITTED: 09Oct63 NR REF SOV: 211

OTHER: 221 DATE ACQ: 19Mar64

Card 4/4

ZEL'DOVICH, Ya.B. (Moskva)

Stability conditions of the combustion of gunpowder in a semi-enclosed volume. PMTF no.1:67-76 Ja-F '63. (MIRA 16:2)
(Gunpowder) (Combustion)

ZAYDEL', R.M.; ZEL'DOVICH, Ya. B. (Moskva)

One-dimensional instability and damping of a detonation. PMTF no. 6:59-65 N-D '63. (MIRA 17:7)

ACCESSION NR: AT4019684 S/2555/63/009/000/0005/0059

AUTHOR: Zel'dovich, Ya. B.

TITLE: Modern physics and astronomy

SOURCE: AN SSSR. Astronomicheskiy sovet. Voprosy* kosmogonii (Problems of cosmogony), v. 9, 1963, 5-59

TOPIC TAGS: elementary particle, physics, astrophysics, astronomy, antiparticle, meson, neutrino, antineutrino, strange particle, charge conjugation, baryon, lepton, electromagnetic interaction, general theory of relativity, special theory of relativity, quantum, gravity, vacuum, Mach principle, universe, gravitational wave, graviton, creation, Jordan theory, cosmology

ABSTRACT: The contemporary status of the physics of elementary particles was reviewed in a lecture given during a theoretical seminar on astrophysics (Tartu, July 7-13, 1962). The following is a partial table of contents: Part I. Elementary particles. # 1. History of discovery of particles. Antiparticles. Mesons. Neutrinos and antineutrinos. Strange particles. New short-lived particles. # 2. Tables of particles. Quanta, leptons and mesons. Charge conjugation. Strongly interacting mesons. Baryons. # 3. Laws of transformation of particles. # 4. Electromagnetic interaction. Interaction

ACCESSION NR: AT4019684

between an electromagnetic field and particles. Dynamic principle of charge conjugation. # 5. Strong interaction and strangeness. # 6. Weak interaction. # 7. Neutrinos and parity. Part II. General theory of relativity and cosmological theories. # 1. Special and general theory of relativity. Cosmological theories. # 2. Experimental confirmations of the general theory of relativity in recent years. # 3. Need for the general theory of relativity . #4. Solution of the equations in the general theory of relativity. #5. Gravitational waves, gravitons and particles. #6. Hypothesis of the creation of matter. #7. Conservation of energy in a closed universe. #8. Hypotheses of varying constants. # 9. General remarks. Orig. art. has: 47 formulas, 1 figure and 2 tables.

ASSOCIATION: Astronomicheskiy sovet AN SSSR (Astronomical Council AN SSSR)

SUBMITTED: 28Nov62 DATE ACQ: 12Mar64 ENCL: 00

SUB CODE: PH NO REF SOV: 005 OTHER: 024

Card 2/2

ACCESSION NR: AT4019689 S/2555/63/009/000/0157/0170

AUTHOR: Zel'dovich, Ya. B.

TITLE: Hydrodynamic stability of a star

SOURCE: AN SSSR. Astronomicheskiy sovet. Voprosy* kosmogonii (Problems of cosmogony), v. 9, 1963, 157-170

TOPIC TAGS: astrophysics, star, hydrodynamic stability, hydrostatic equilibrium, hydrodynamic process, nuclear process, star formation, gravitational energy, star model, general relativity theory

ABSTRACT: The author considers the problem of the stability of a spherically symmetrical body, contained by gravitational forces, relative to radial movements of matter in which the condition of hydrostatic equilibrium is disrupted. The problem is considered in two different approximations. In Section 2, all the matter of a star is characterized by mean indices - mean density and mean pressure. A study is made of the dependence of stability on the equation of state of matter. This method is approximate, but it is more graphic in presentation of the general concept of slow evolution (dependent on the velocity of nuclear processes), leading the system to the limit of stability, after which there is catastrophic compression and the release of gravitational energy. These considerations are discussed in

ACCESSION NR: AT4019689

Section 3. Section 4 is devoted to an exposition of the concepts of N. A. Dmitriyev, which can be used to obtain a precise solution of the problem of stability of an equilibrium model of a star with an arbitrary equation of state of matter and an arbitrary distribution of entropy and material composition. It is shown that the stability criterion can be formulated by comparing the solution with a solution corresponding to a different but similar mass. The precise solution confirms the conclusions drawn in Section 2 on the basis of an approximate consideration of the problem. Another approach to solution of the problem of stability is based on the work of Barenblatt and Zel'dovich (Dokl. AN SSSR, 118, 671, 1958); this also remains in force when the general theory of relativity is taken into account. Section 5 discusses the reasons for the smallness of the adiabatic indices leading to instability; nuclear processes are classified as rapid (equilibrium and slow) and evolutionary. Section 6 gives a qualitative discussion of the change introduced by the general theory of relativity (the problem to this point had been considered on the basis of the Newtonian theory). "The author thanks N. A. Dmitriyev for the concepts used in this study, A. G. Masevich, D. A. Frank-Kamenetskiy and other colleagues at the Tartu summer school for discussions, and G. A. Pinayeva for assistance in finalizing the study". Orig. art. has: 18 formulas and 3 figures.

ASSOCIATION: ASTRONOMICHESKIY SOVET AN SSSR (Astronomical Council,AN SSSR)

Card 2/3

ACCESSION NR: AT4019689

SUBMITTED: 29Sep62 DATE ACQ: 12Mar64 ENCL: 00

SUB CODE: AS NO REF SOV: 008 OTHER: 009

Card 3/3

APPROVED FOR RELEASE: 03/15/2001 CIA-RDP86-00513R001964220013-3"

ACCESSION NR: AT4019695 S/2555/63/009/000/0232/0239

AUTHOR: Zel'dovich, Ya. B.

TITLE: The prestellar evolution of matter

SOURCE: AN SSSR. Astronomicheskiy sovet. Voprosy* kosmogonii (Problems of cosmogony), v. 9, 1963, 232-239

TOPIC TAGS: astrophysics, cosmogony, astronomy, nuclear process, neutrino, lepton, entropy, prestellar matter, barion, antineutrino

ABSTRACT: A study was made of the stages in the expansion of matter and of those nuclear processes which occur at these early stages. One of the basic problems discussed is whether or not the concept of the expansion of matter of infinite density is compatible with the general concepts concerning the composition of prestellar matter, and especially the predominance of hydrogen in this matter. In investigating this problem the author considers four variants: first, the zero initial entropy and zero lepton charges; second, the high initial entropy, with lepton charges equal to zero; third, the zero entropy with a negative lepton charge; finally, the zero entropy with a positive lepton charge. The latter model

ACCESSION NR: AT4019695

is considered correct and the only one of the variants possible. Zero initial entropy and a lepton charge + 2 (per barion) leads to prestellar matter consisting of pure hydrogen. With the present-day mean density of nucleons of 10^{-30} g/cm^3, the neutrino density is $6 \cdot 10^{-7}$ cm^{-3}, their Fermi energy is 10^{-6}ev, and the density of the mass of neutrinos is 10^{-39} g/cm^3. The hypothesis that the initial matter for the stellar stage of evolution was pure cold hydrogen is in full agreement with present-day astrophysical concepts. The basic conclusions of this article have been published earlier by the author (Atomnaya energiya, 14, 92, 1963; ZhETF, 43, 1561, 1962). Orig. art. has: 4 formulas.

ASSOCIATION: Astronomicheskiy sovet AN SSSR (Astronomy Council AN SSSR)

SUBMITTED: 06Sep62 DATE ACQ: 12Mar64 ENCL: 00

SUB CODE: AA NO REF SOV: 005 OTHER: 007

Card 2/2

ACCESSION NR: AT4019696 S/2555/63/009/000/0240/0253

AUTHOR: Zel'dovich, Ya. B.

TITLE: Formation of stars and galaxies in the expanding universe

SOURCE: AN SSSR. Astronomicheskiy sovet. Voprosy* kosmogonii (Problems of cosmogony), v. 9, 1963, 240-253

TOPIC TAGS: astronomy, astrophysics, star formation, gravitational instability, universe, expanding universe, star, galaxy

ABSTRACT: The theory of gravitational instability in a expanding universe is reviewed. The assumption that universal gravitation is the principal reason for the presently observed grouping of matter is discussed, beginning with the classical Jeans theory. Primary attention is given to the work of Ye. M. Lifshits on this problem, who developed the theory by introduction of the general theory of relativity. In this paper the author attempts to demonstrate that at a particular stage in the expansion of matter there was a phase transition; the greater part of his study attempts to substantiate this hypothesis. However, as indicated by a note added during proofing, the author himself no longer supports the thesis he advanced at the Tartu seminar in July 1962; the difficulties pointed out in the original paper have since been found still more insuperable than the author believed

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ACCESSION NR: AT4019696

initially. His hypothesis that initial fluctuations of density are due to cavitation and evaporation of the uniform cold matter of the prestellar medium now seems improbable; he suggests an investigation of thermodynamic fluctuations at densities far greater than nuclear. The printed article is nevertheless of merit because it is an analysis of the concepts of Jeans, Lifshits and Bonnor. Orig. art. has: 1 formula.

ASSOCIATION: Astronomicheskiy sovet AN SSSR (Astronomical Council AN SSSR)

SUBMITTED: 18Sep62 DATE ACQ: 12Mar64 ENCL: 00

SUB CODE: AS NO REF SOV: 007 OTHER: 009

APPROVED FOR RELEASE: 03/15/2001 CIA-RDP86-00513R001964220013-3"

ZEL'DOVICH, Ya.B.

Loss of mass of supergiant stars by neutrino emission. Astron. tsir. no. 250:1-5 Jl '63. (MIRA 17:5)

1. Otdeleniye prikladnoy matemtiki AN SSSR.

S/089/63/014/001/009/013
B102/B186

AUTHOR: Zel'dovich, Ya. B.

TITLE: The initial stages in the development of the universe

PERIODICAL: Atomnaya energiya, v. 14, no. 1, 1963, 92-99

TEXT: The problems arising when one considers the development of the expanding universe according to the theories of Landau (Dokl. AN SSSR, 17, 301, 1937), of Gamow (Rev.Mod.Phys., 21, 367, 1949) and of Alpher and Herman (Rev. Mod. Phys., 22, 153, 1950; Ann. Rev. Nucl. Sci., 2, 1, 1953) are discussed. If, as Landau assumed, the initial state of matter was a cold neutron mass, it necessarily follows that on expansion this neutron mass is transformed into a tritium - helium mixture practically free from hydrogen. This completely contradicts the scientifically founded assumption about the state of matter prior to the formation of the stars. The Gamow theory, according to which the original matter was so hot that the radiation density exceeded the nucleon density by several orders of magnitude, also encounters certain difficulties when processes taking place in hot matter are considered. A theory of prestellar development

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must not only explain the formation of a matter which should have consisted of at least 90% hydrogen, but must also yield a definite distribution of the energy in various forms. According to the Gamow theory the present radiation density must still exceed the density of matter by an order of magnitude if the data on the age of the universe are to agree. Here, then, a new hypothesis on the primordial matter is briefly outlined. It is assumed that the primordial matter consisted of a cold mixture of protons, electrons and neutrinos in equal numbers. In this matter all states with $E < E_{Fermi}$ of neutrinos are occupied. At high densities the neutrinos stabilize the protons, at low densities they are stable by themselves. The primordial medium is assumed to be homogeneous so that no possibility exists for the neutrinos to escape. If the proton density is 10^{14} g/cm^3 (that is $6 \cdot 10^{37}$ protons/cm^3 with equal numbers of e^- and ν_e per cm^3) the Fermi energy of the electrons equals 400 Mev and that of the neutrinos 500 Mev. A neutron formation is excluded. At still higher densities processes like $\nu_e \rightarrow e^- + \mu^+ + \nu_\mu$ or hyperon formation are possible. The ratios are always such that, if during the course of

The initial stages in the ... S/089/63/014/001/009/013
B102/B186

expansion the stage of nuclear density is passed through the uniform p, e^-, ν_e distribution continues to prevail. For the formation of stars the first element available is pure hydrogen; other elements are formed in the course of the stars' formation. The neutrino Fermi energy has during the expansion of the universe decreased up to the present time now proportionally to $\sqrt[3]{\varrho}$ and is $2 \cdot 10^{-6}$ ev. A final decision about whether the Gamow hypothesis or the one proposed here is true would be possible if the helium density in the old stars and the intergalactic radiation density were known.

SUBMITTED: October 6, 1962

Card 3/3

ZELDOVICI, I.B. [Zel'dovich, Ya. B.]

Problems of modern physics and astronomy. Analele mat 17 no. 3:57-91 Jl-S '63.

DOROSHKEVICH, A.G.; ZEL'DOVICH, Ya.B.

Development of perturbations of arbitrary form in a homogeneous medium with low pressure. Astron. zhur. 40 no.5:807-811 S-O '63. (MIRA 16:11)

GANDEL'MAN, G.M.; YERMACHENKO, V.M.; ZEL'DOVICH, Ya.B.

Nonmetallic nickel under high pressures. Zhur. eksp. i teor. fiz. 44 no.1:386-387 Ja '63. (MIRA 16:5)

(Nickel) (High-pressure research)

DMITRIYEV, N.A.; ZEL'DOVICH, Ya.B.

Energy of random motion in the expanding universe. Zhur. eksp. i teor. fiz. 45 no.4:1150-1155 O '63. (MIRA 16:11)

ZEL'DOVICH, Ya.B.

A.A.Fridman's theory of the expanding universe. Usp. fiz. nauk 80 no.3:357-390 Jl '63. (MIRA 16:9)
(Cosmology) (Fridman, Aleksandr Aleksandrovich, 1888-1925)

ACCESSION NR: AP3000512

AUTHOR: Zel'dovich, Ya. B. (Academician)

61
62

TITLE: Ignition theory

SOURCE: AN SSSR. Doklady, v. 150, no. 2, 1963, 283-285

TOPIC TAGS: ignition theory, thermal explosion, hot wall ignition

ABSTRACT: The following three mechanisms are considered to take place in a combustible mixture contained in a vessel whose walls have a higher temperature (T_c) than the combustible (T_0)(r_1 and r_2 are the critical radii of the vessel for the regimes specified). 1) When $r < r_1$, the initial temperature of the combustible exceeds the wall temperature only slightly. 2) When $r_1 < r < r_2$, the entire combustible mixture is ignited by thermal explosion and a maximum temperature is attained in the entire vessel. 3) When $r > r_2$, the combustible is ignited by the wall and a temperature maximum is attained in the vicinity of the wall, with the center of the combustible mixture being heated subsequently by the propagating flame. The following equation was derived for determining the minimum critical radius for (3):

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L 10534-63
ACCESSION NR: AP3000512

$$\tau_2 = \frac{\theta_0}{\sqrt{2\pi}} \sqrt{\frac{\kappa R T_c^2}{A E e^{-\frac{E}{RT_c}}}} \cdot \ln \frac{\theta_0 \sqrt{\pi}}{k}$$

where

$$\theta_0 = (T_0 - T_c) \frac{E}{RT_c^2}$$ [κ = thermal diffusivity E = activation energy].

The formula shows that τ_2 is dependent on the initial temperature of the mixture. The constant k could not be determined within the considered approximation and can have different values depending on the vessel geometry (cylindrical, spherical, or flat). However, it may be assumed that the formula yields useful results when k = 0.5 and $\theta_0 >> 1$. The formula $\tau_1 = \theta_0 2/2\pi$ was derived for the induction period in the ignition by hot walls. "I take advantage of this opportunity to express my thanks to F. I. Dubovitskiy, who brought the given question to my attention, and to authors A. G. Merzhanov, V. G. Abramov, and V. T. Gontkovskaya

Card 2/3

L 10591-63
ACCESSION NR: AP3000512

(DAN, 148, No. 1, [1963]) for making it possible for me to acquaint myself with the work in the manuscript." Orig. art. has: 18 formulas.

ASSOCIATION: Institut khimicheskoy fiziki Akademii nauk SSSR (Institute of Chemical Physics, Academy of Sciences, SSSR)

SUBMITTED: 04Feb63 DATE ACQ: 12Jun63 ENCL: 00

SUB CODE: PR NO REF SOV: 003 OTHER: 000

ch/

Card 3/3

AMBARTSUMYAN, V.A., akademk; GINZBURG, V.L.; ZEL'DOVICH, Ya.B., akademik; PONTEKORVO, B.M.; SMORODINSKIY, Ya.A., doktor fiz.-matem. nauk, prof.; FOK, V.A., akademik, CHERNOV, A.G.; FAYNBOYM, I.B., red.

[Birth and evolution of the galaxies and stars; the third discussion] Rozhdenie i evoliutsiia galaktik i zvezd; beseda tret'ia. [By] V.A.Ambartsumian i dr. Moskva, Izd-vo "Znanie," 1964. 27 p. (Novoe v zhizni, nauke, tekhnike. Seriia IX: Fizika, matematika, astronomiia, no.12)
(MIRA 17:6)

1. Chlen-korrespondent AN SSSR (for Ginzburg, Pontekorvo).

ACCESSION NR: AP4041202 S/0207/64/000/003/0126/0138

AUTHOR: Zel'dovich, Ya. B. (Moscow)

TITLE: On the combustion rate of powder under variable pressure

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 3, 1964, 126-138

TOPIC TAGS: combustion rate, powder, steady state combustion, pressure ratio, extinction, spontaneous combustion

ABSTRACT: The combustion rate of powders under high-speed or low-speed pressure changes was studied analytically, and the results were compared with existing experimental data. Parametric equations are given for steady state combustion as a function of pressure p and temperature gradient ϕ

$$u_0 = u\,[p, \varphi_0(u, T_0)]$$

$$u_0 = u_0^{\circ}(p, T_0)\ .$$

Under high-speed pressure changes these equations appear in the form u(p, ϕ). Taking the total differentials of the above equations and using the designations

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ACCESSION NR: AP4041202

$$\nu = \frac{p}{u}\left(\frac{\partial u}{\partial p}\right)_{T_0} = \left(\frac{\partial \ln u}{\partial \ln p}\right)_{T_0}$$

$$\beta = \frac{1}{u}\left(\frac{\partial u}{\partial T_0}\right)_p = \left(\frac{\partial \ln u}{\partial T_0}\right)_p$$

, an expression is derived for rate of change of combustion with p, or

$$\left(\frac{\partial u}{\partial p}\right)_\varphi = \frac{\nu}{1-\beta(T_k-T_0)}\,\frac{u}{p}.$$

Furthermore, for a combustion rule given by $u = u_1 p^\nu$, the initial-to-final pressure ratio during the combustion is expressed as a function of β, initial temperature T_0, and carburation temperature T_K,

$$\left(\frac{p_1}{p_0}\right)^\nu = \frac{1}{\beta(T_k-T_0)}\,e^{\beta(T_k-T_0)-1}.$$

The above results are then represented graphically. They include: 1) temperature distribution on the powder surface T versus x; 2) $u(T_0)$ and $\varphi\ (T_0)$ under constant pressure, corresponding to steady state combustion; and 3) u as a function of φ under a given pressure. In this latter example (see Fig. 1 on the Enclosure)

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